ASSESSING NUTRITIONAL AND CLIMATE LIMITATIONS TO THE PRODUCTIVITY OF *EUCALYPTUS* PLANTATIONS AT LARGER SPATIAL AND TEMPORAL SCALES USING A SIMPLE PAIRED-PLOT DESIGN COUPLED TO TRADITIONAL INVENTORY NETWORK

José Luiz Stape[1], Jacyr Mesquita Alvez[2], Ernesto Takahashi[3], Walmir Franciscate[3] and Walter Jacob[3]

[1]Department of Forest Sciences, University of Sao Paulo C.P.9, Piracicaba, SP 13418-970, Brazil (stape@esalq.usp.br)
[2]Copener Florestal Ltda, Alagoinhas, BA, Brazil (copener@copener.com.br)
[3]Votorantim Celulose e Papel, Luis Antonio, SP, Brazil (ernestont@vcp.com.br)

INTRODUCTION

The productivity of *Eucalyptus* plantations in tropical regions is generally restricted by edaphic (e.g. low fertility soils), climatic (e.g. droughts) or competing (e.g. weeds) conditions. In Brazil, the actual productivity of *Eucalyptus* forests is traditionally estimated throughout the use of permanent inventory plot networks, with a sampling intensity of 0.2 to 0.6%, representing 1 inventory plot (400 to 600 m²) for each 10 to 20 ha of plantations. These plots are measured every year, or every other year. Although these inventories provide adequate estimates of the wood stock and forest actual productivity, they do not provide any information regarding the potential productivity of these plots (if there were no growth constraint). Addressing potential productivity using traditional trials requires expensive factorial designs, which tends to be concentrate in a small portion of the regional landscape, restricting the generalization power desired for such studies. Knowing the existing gap between actual and potential productivity at the regional level, and under different climatic conditions, is fundamental for adequate forest management, improving site-specific silvicultural procedures, and as a research tool, identifying and defining the priorities for research investments.

MATERIALS AND METHODS

In order to estimate these gaps between actual and potential productivities, at regional scales, and for different climate conditions, a paired-plot design was established at two forest locations in Brazil (Bahia State at 11º S and Sao Paulo State at 21º S), using the existing inventory networks. Networks stratification was based on farm locations, soil types, age- and site-index classes. From the available plots, a subset was randomly selected proportionally to the stratification criteria, representing from 5 to 8% of the inventory network plots. For those selected, a paired-plot was installed 15 to 30 m apart in the same genetic material and soil (nicknamed “twin-plots”). These paired-plots started receiving intensive care management, with regular pests and weeds controls and high fertilization rates (400 kg ha^{-1} N, 40 kg ha^{-1} P, 70 kg ha^{-1} K, 600 kg ha^{-1} Ca, 300 kg ha^{-1} Mg, plus micronutrients) applied during the year. The DBH and height measurements were taken every 6 months, at the beginning and end of the rainy period, providing adequate estimates of the productivity with and without adequate water supply. A total of 60 paired-plots were installed at Bahia State in July 1999, and 128 paired-plots at Sao Paulo State by February 2002, and measure during two years.

RESULTS AND DISCUSSION

At Bahia State, the average productivity (as Current Annual Increment) was 22.2 Mg ha^{-1} yr^{-1} and results showed that the average gap between actual and potential productivity was 2.2 Mg ha^{-1} yr^{-1} during the dry period, reaching 8.6 Mg ha^{-1} yr^{-1} during the wet period, indicating that water was the most important constraint to forest growth (Figure 1). Foliar and soil analyses carried out during the period and correlated with the fertilization response variable indicated that N, P and K were the main nutrients affecting productivity. At Sao Paulo State, for the first year the average productivity was 17.4 Mg ha^{-1} yr^{-1} and the average gap was 1.8 Mg ha^{-1} yr^{-1} during the dry period, and reaching 6.5 Mg ha^{-1} yr^{-1} during the wet period. Fertilization responses were higher for the sandy, low fertility quartzpsanment soils, indicating the need of a more intense fertilization. The first year results at Sao Paulo sites are shown on Figure 2. Soil and leaf analysis will be available on July 2004 and incorporated on this paper.

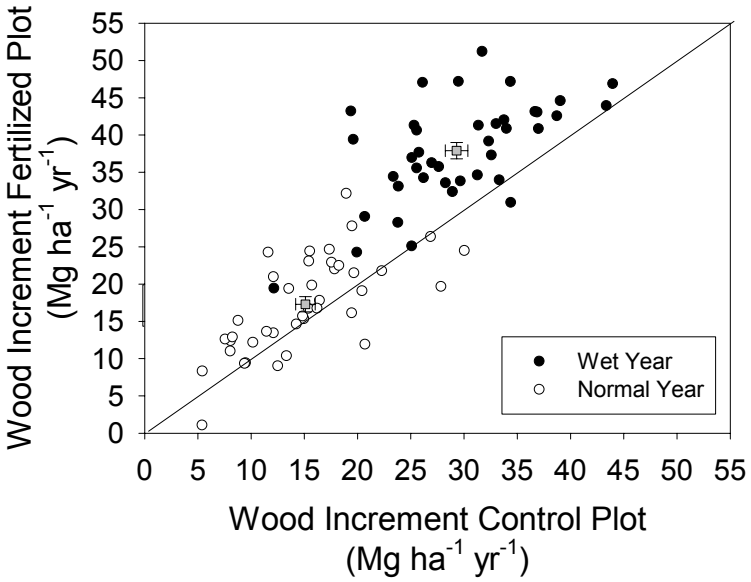

Figure 1. Wood increments during wet and normal years at the 40 Bahia State sites during 1999/2000 and 2000/2001. Gray squares represent the average growth for the years with standard error bars. Potential productivity was 29% higher than actual observed productivity during the wet year, and 15% higher during the dry year

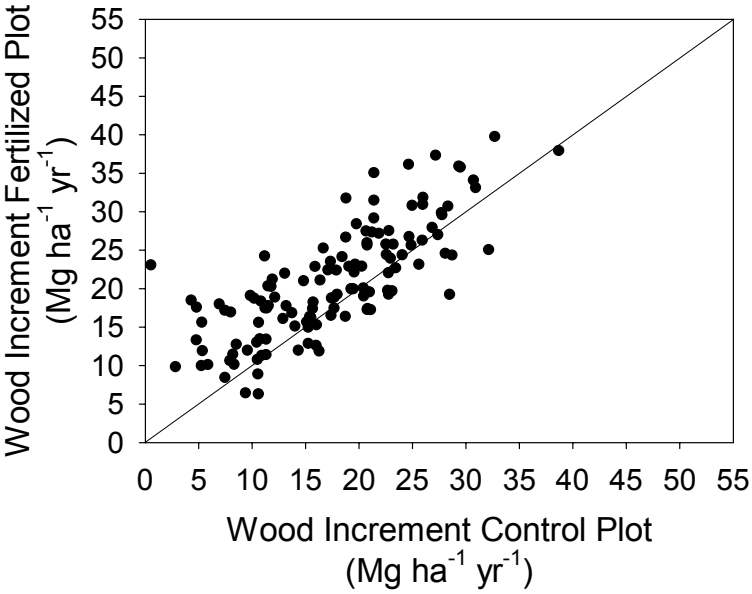

Figure 2. Wood increments during 2002/2003 year at the 128 Sao Paulo sites, showing that potential productivity was 20% higher than actual observed productivity during this period

Overall, the paired-plot design has showed to be easily implemented, at a low cost, and with rapid and robust estimates of the gap between actual and potential productivity for the different criteria used on plot selection, allowing both operational and research decisions to guarantee the productivity and sustainability of fast-growing *Eucalyptus* forests in the tropics.